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No. 54

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CHEMICALS

SWEDISH FIRM TO MAKE PLASTIC ENGINE EXHAUSTS FOR ARIANE

Stockholm NY TEKNIK in Swedish 22 Jan 81 pp 17

> [Text] The exhaust for the rocket engines of the Ariane rocket may in the future be made of plastic instead of steel because plastic can withstand higher temperatures.

It is the Volve Flygmotor in Trollhattan which is manufacturing exhaust pipes and combustion rooms for the engines of the Ariane rockets, the transport rockets which a number of European countries, headed by France, are developing. The material in the exhaust is a highly tenacious steel with cobalt alloying. The inside of the pipe, or the dress, as it is also called, is covered with a layer of zirconium oxide which protects the steel against the hot gasses.

Future versions of Ariane will be furnished with more power so that the lifting capability will be increased. The engines are burning for a longer period of time, and the temperature in the dress in increased. Because of this, we are now considering making the dresses of fiber-reinforced plastic because this sort of plastic can withstand higher temperatures since it boils on the outside and thereby emits an isolating film of gas.

Volvo Flygmotor is now studying the possibilities of manufacturing the plastic dresses. However, Ulf Olsson of the plant is doubtful whether, on the one hand, it is necessary to change over to plastic, and, on the other hand, in case it is necessary, if Flygmotor should undertake the manufacturing.

Of course, they are now producing plastic dresses for smaller engines. However, that is a bit outside the usual line of business.

A decision is expected after the next trial shot of Ariane which is planned for this spring, after a delay of months. The manufacturing of plastic dresses is to start in 1983.

9667
CSO: 3102

ELECTRONICS

OPTICAL STORAGE DISC TO BE READY FOR USERS BY 1984

Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 19 Feb 81 p 7

[Article: "Optical Storage Disc Soon Ready for Use. Philips Starts First Tests/Text of 500,000 Pages, DIN [German industrial standard] A-4 Size Fit on One Disc"]

[Text] The optical storage disc seems to have technically matured soon after progress, primarily with smaller compact laser devices, was made. As recently revealed by the company in Siegen, at present five preproduction models in various research and application projects are being tested in practice. In the next 2 years five additional pilot projects are to be realized in order to acquire additional possibilities for improvements in the user interfaces and peripheral units within the framework of user testing of the overall system. Effective 1984 the plan calls for operational installations of closed Philips systems, using the optical storage disc, as systems of information storage and information. They are also contemplating a comprehensive data bank system.

According to Philips, far more than DM100 million have been invested in this research project since 1972 on up to the beginning of the preproduction series. But the company still sees itself faced with a development cost in software of an additional 50 to 100 man years. The company says that the projected cost of the data carrier would then be somewhere near DM800 (1984). The cost of a reading-printing station in 1984 could possibly be found to be on the order of DM250,000 to 300,000; in the course of series production it would be possible to reduce the factory cost to about DM100,000.

Some time ago Philips had introduced the prototype of this first optical disc storage system in the world with diode lasers. The extremely compact storage device can record and read out data with high density. A rotating, two-sided plastic disc, with prestamped tracks, 30 cm in diameter, serves as a storage medium. The disc stores a quantity of information equal to about one-half million typewritten pages of text. The company says that is thus superior to the largest magnetic disc storage systems which have been announced today in computer systems.

The idea of using lasers of optical data storage came very early, yet technical problems stood in the way of developing a usable writing-reading storage system. Such a recording system requires a very small laser and optical systems with modest dimensions and a storage medium which is suitable for long-term storage. Philips found itself in a favorable starting position to produce the technical requirements because, parallel with this, the development of the VLP-video disc was already in existence. Moreover, the improvement of the diode lasers was decisive. It was just as successful as the development of a suitable material for the storage layer.

The optical storage disc consists of two transparent carriers, which, at the end of the manufacturing process, are joined in a sandwich technique into a "double disc" with an air space in between. On each side there is a prestamped spiral track, 0.6 micrometers wide and 0.06 micrometers deep, which has a total of 45,000 turns. The track serves to position the writing-reading head in a radial direction, the center-to-center distance between tracks is 1.6 micrometers. Each track turn is divided into 128 sectors with a so-called address lable which--as is also true of the track--is imprinted during production of the storage disc. After imprinting, the actual storage layer, a material 300 angstroms thick and containing tellurium, is vapor deposited. The label contains information for synchronisation and about track and sector number.

The diode laser used is an aluminum-gallium-arsenide-DH-type and consists of a semiconducter minidisc with an edge length of 0.1 millimeter. It gives off radiation with a wave length of 820 nanometers. In spite of the modest dimensions the pulsating light source has such a high output that it can replace a gas laser and the mudulator belonging to it. The laser is built into the extremely compact optical system, which, moreover, contains the optical electronics for track sharp focusing, track follow-up and focusing. The supply current of the laser is modulated for writing.

When writing, the laser beam burns tiny holes with a diameter of 1 micro-meter into the active storage layer with tellurium. The data bits, which are entered into the disc in this way, are immediately reread after that. The optical electronics distinguishes the difference between the strong light which is reflected by the undisturbed reflective layer and the weak light which comes from a hole that has been burned. The two different levels of brightness are transformed into a binary electrical signal and represent the data bits. When reading and writing, the laser light is focused by means of the 1-millimeter thick transparent surface covering on the inner storage layer. Thus, according to Philips, there is a high level of protection against problems from dust, finger prints or scratches. It is possible to enter 1 K bits net into each of the individually addressable 45,000 times 128 sectors.

According to Philips, the optical storage disc "originally" contains a prestamped track whose depth overall is approximately one eighth of the wave length of the laser light. Because even the address label was imprinted into the sectors during disc manufacture, the optical system can follow the imprinted track, independently of whether data were already written in or not and at the same time search and read the address label.

Accurate writing and reading of the data is guaranteed by suitable data modulation, introduction of code words into the sectors and high redundancy. In this way, while writing, 99.9 percent of all errors can be identified immediately and automatically corrected in the same sector by means of the electronic error correction system. The other 0.1 percent of errors are, of course, likewise identified by the system, but can no longer be automatically corrected immediately. In these rare cases, the system reenters the data in question in another sector. But for the user this means that the storage system functions without error.

Philips sees two different areas of application for the optical storage discs: on the one hand, the storage of alphanumeric information, on the oth r, facsimile storage. Facsimile storage requires huge storage capacities which the new storage medium now offers. According to Philips, since texts and facsimiles can be written and read with rapid access times, the optical storage disc has good chances of becoming an electronic counterpart of paper and microfilm. A further advantage is also the capability of storing for long periods of time (archive capability), which makes it possible for the optical storage disc to replace magnetic media in many applications. These include, among others, special large data files, as are used for a display screen text system. According to Philips the data density is based on bits/inch^2 substantially higher than in magnetic storage media and this ratio will probably become even greater in the future.

12124
CSO: 3102

BRIEFS

MICROELECTRONICS IN MACHINE BUILDING--A study on German machine building, which was just put forth by the VDI-[association of German Engineers] Center for Technology, Berlin, comes to the conclusion that the leading market position of this branch of industry internationally can also be preserved in the future. A prerequisite for this is, of course, accelerated and extensive introduction of microelectronics before foreign competition makes significant inroads in the market of German companies. This will, however, be coupled with a number of surmountable initial difficulties which are in part psychological and part practical in nature. These are the basic results of a just completed study on German machine building which was supported by the Ministry for Research and Technology (BMFT) and was implemented by the "Microelectronics in Machine Building" task force by order of the VDI-Center for Technology, Berlin. In contrast to a currently low level of utilization of microelectronics in the products of machine building, by far the greatest part of this branch has discovered that microelectronics will be the technology with the highest rate of growth which can be expected. In this, machine building proceeds on the basis of the idea that the use of microelectronics will result in an increase in flexibility, reliability, scope of application, service ease and space utilization. In the view of a number of machine building companies, of course these positive effects are also offset by several negative effects which can be attributed basically to inadequate technology, insufficient personnel, high costs of introduction and several other difficulties. [Text] [Essen ELEKTRO-ANZEIGER in German No 1/2 1981 pp 14-15] 12124

CSO: 3102

ENERGY

STATE OFFERS LEGAL, FINANCIAL INCENTIVES TO SOLAR USERS

Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 16 Feb 81 p 7

[Text] Frankfurt, 15 February--Financial incentives for the use of solar energy in the FRG are one side of the Federal Government's measures. Legal regulations which must be obeyed in the case of solar installations are the other side. The financial incentives can be summarized thus:

1. An energy savings supplement of 25 percent of the subsidizable costs, which amount to DM 12,000 per house. The program expires in 1982. So an allowance of DM 3,000 can be applied for. Regulations vary in the individual Laender. Normally, application for the energy savings supplement for installation of a solar plant is made through the local administration.

2. A write-off of 10 percent annually over 10 years, that is, a maximum of DM 1,200 in one year. This must be claimed on one's income tax statement.

3. For businesses which come under paragraph 4 a of the investment allowance law, there is an allowance of 7.5 percent in addition to the purchase and manufacturing costs. Application should be made through the office of Business Economics confirming that the investment is particularly suitable for saving energy. The appropriate form for applying for issuance of confirmation of energy saving installations can be obtained from the Office for Business Economics (Referat IV/9, Frankfurter Strasse 29, 6236 Eschborn/Taunus 1).

4. Project assistance under the federal government's energy research program and programs of the EEC, information on EEC support (loans and other assistance from the EEC) can be obtained from the Press and Information Office of the EEC Commission, Zitelmannstr. 22, 5300 Bonn. Information about the federal program can be obtained from the nuclear research facility in Juelich, Project Supervision and Energy Research (PLE), P.O. Box 1913, 5170 Juelich 1.

5. Aid is also available under the EEC project "Improvement of the Agrarian Structure of Coastal Protection." Applications, which can be obtained from the Office of Agriculture, can be submitted by landowners deriving their principal income from farming and operators of hot-air drying facilities. Assistance can only be granted if the amount of the investment that can be supported is DM 250,000. Twenty-five percent of the subsidizable investment amount can be permitted as an allowance.

6. ERP [European Recovery Program] programs with low-interest loans through the Reconstruction Loan Corporation. One's own bank [illegible] information.

7. There are programs run by the Land in Bavaria, Baden-Wuerttemberg and Lower Saxony. Details can be obtained from the Land minister of economics in charge.

The remaining legal aspects of solar installations should be observed scrupulously before an application is made. Preliminary inquiries at the responsible building authority are indispensable. The situation concerning approval of heat pumps which draw heat from ground water varies widely, the same is true of wind energy. Collectors and solar energy roofs are approved relatively easily.

9581
CSO: 3102

ENERGY

GOVERNMENT INCREASES FUNDING FOR COAL CONVERSION PLANTS

Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 26 Feb 81 p 7

[Text] Frankfurt, 25 February--In the federal budget both the Ministry for Research and the Ministry of Economics have funds allocated for the next several years to support coal conversion plants. The work has been divided so that the Ministry for Research is to confine itself to measures to support development costs, and the Ministry of Economics to direct assistance for the construction of the coal conversion plants. The plan figures for the next few years are: Research funds from the Ministry for Research for coal gasification plants (in millions of DM) 1981: 153.8, for 1982: 131.0, for 1983: 120.0, for 1984: 100.0. In the Ministry of Economics the figures are: 1981: 25.0, for 1982: 195.0, for 1983: 200.0, for 1984: 400.0. Total funds to support coal conversion will therefore rise in the next few years from DM 179 million in 1981 to DM 500 million in 1984. The Ministry for Economics has now established guidelines for approving investment assistance to coal conversion plants. The guidelines give details for approving aid to businesses with headquarters in the FRG for coal conversion plants. The basic principles of these guidelines are:

--assistance from other public sources as well as from third parties reduce the need for federal aid

--assistance is granted in the form of interest-free, conditionally repayable subsidies

--investment cost assistance must not exceed 50 percent of the investment costs

Additionally, assistance for the use of German coal is described in detail compared with imported coal.

The government intends to make a policy decision this year concerning further support for coal conversion plants. Now only 12 of the originally planned 14 coal conversion plants. Now only 12 of the originally planned 14 coal conversion plants will be continued. In view of the high investment costs of about DM 5 billion for 1 coal conversion plant with an annual capacity of 6 million tons, even with subsidies of 50 percent of the investment costs federal funds will most likely not be sufficient, also considering an 8-year construction period. With the funds that the government has set aside in its mid-range financial planning, one large coal conversion plant at most can be partially financed.

9581
CSO: 3102

ENERGY

BRIEFS

OIL FROM PEAT -- Oil can be produced from peat. A laboratory equipped for this, building on a two-step process, will be built in Stockholm at the Institute of Chemical Technology. While the coal countries are investing great resources in order to develop processes for coal gasification, one ought now to work on similar processes for peat gasification, said professor Olle Lindstrom to the Science Academy's magazine, AMBIO. He claims that the further development of this should be an international collaboration project. The oil which can be manufactured from peat has a lower sulphur and nitrogen content than the solid peat fuel. The peat process which compares with the coal gasification method has great potential since it combines de-humidification and fuel manufacturing. Four attempts--the article rendered an account of somebody's experience with 83-90 percent of the peat converted. The yield of the coalwater production varies in the four experiments from between 26 to 44 percent (the caloric value is 35.2-37.4 Mj/kg). [Text] [Stockholm NY TEKNIK in Swedish 12 Feb 81 p 48] 9667

CSO: 3102

INDUSTRIAL TECHNOLOGY

BRIEFS

NEW STEEL PROCESS -- By mixing cold iron powder into the liquid steel while at the same time pouring it into the mold, one can accomplish a quick, continuous casting process for steel. The secret is the quick cooling of the liquid which results in steel of a uniform and high quality. In 10 to 15 years this method will probably be used to cast broadband instead of rolling it. The novelty of the method is to be able to cool down the liquid steel in a very fast manner. This happens by adding iron powder of the same combination as the liquid steel during the casting. Technically, this is done with the help of pressurized gas which "blows" the powder into the entire liquid. The powder then functions as a heat exchanger, soaking up heat while at the same time cooling down the liquid very quickly. In this way, a very uniform and high quality steel is obtained. The method is the result of doctorate research at KTH by Bjorn Frykendahl, who has also taken out a patent in the most important industrial countries. Sven Eketorp, who is the examiner, thinks that this energy-saving casting method is going to revolutionize the steel industry. [Text] [Stockholm NY TEKNIK in Swedish 29 Jan 81 p 3] 9667

CSO: 3102

SCIENCE POLICY

REPORT PUBLISHED ON R & D EXPENDITURES 1977-1980

Paris LE PROGRES TECHNIQUE in French No 20,1980 p 21

[Article: "During 1980, for the First Time, More than 20 Billion Deutschmarks Will Be Spent for Industrial Research and Development"*]

[Text] The German Science Foundation has published the results of its statistical studies in "Research and Development in the Economy During 1977." This publication also furnishes the forecasts of research and development expenditures by the companies for the years 1978 through 1980. For the first time, it has furnished information regarding districution of expenditures and of research and development work forces by region. An international comparison is also presented. Here are the most important results:

According to the estimates furnished by the various companies, the total research and development expenditures of the industrial sector will amount to DM 21 billion for 1980. This corresponds to an annual increase of approximately 7 percent since 1977.

In 1977, this total was 17.2 billion and the portion financed by industry amounted to DM 14.1 billion.

In 1977, 81.4 percent of the total research and development expenditures were made in the following five areas: chemical industry (25.9 percent), electro-technology (25.9 percent), automobile construction (11.9 percent), machine construction (10.3 percent) and aeronautical construction (7.4 percent). Research and development expenditures in these fields has decreased since 1971, when they accounted for 85.7 percent of the total.

The research and development expenses of the small and medium-sized industries have increased greatly in recent years. Whereas, from 1971 to 1977, the expenditures for all the companies increased by an average of 10.7 percent per year, those for firms with less than 1000 workers increased annually by 21.9 percent and those for companies employing from 1000 to 4999 people rose by 16.3 percent annually.

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* This text and the following one are translations of extracts of articles appearing in the October 1980 issue of the AI magazine "Forschung Entwicklung."

7619
CSO: 3102

SCIENCE POLICY

TWO NEW PROGRAMS FOR AID TO INDUSTRIAL RESEARCH ASSESSED

Paris LE PROGRES TECHNIQUE in French No 20, 1980 pp 20-21

[Article: "The AIF and the Research and Development Effort Among the Small and Medium-sized companies. (Note from the Scientific Services of the French Embassy in Bonn)."]

[Text] The Federation of Industrial Research Associations (AIF) held its annual meeting in Cologne on 20 and 21 May 1980. On this occasion, it prepared a preliminary draft of the two new programs for providing assistance for the research and development effort directed by the AIF.

The AIF is a union of collective industrial research agencies (the initiative for creating it in 1954 was taken by a number of these agencies). It cooperates with the large institutions which also conduct industrial research such as the Fraunhofer Company, as well as representatives of the industrial divisions or activities. It has finally been designated by the federal government to act as a partner of the ministries concerned with directing the measures that they take with regard to helping research and development among the small and medium-sized firms. Approximately only one-third of the public funds allotted to encourage the research and development activities of small and medium-sized firms flows through this agency. The AIF now unites 87 research associations, organized into divisions and dealing with approximately 20,000 companies. The AIF is responsible for the functioning of the autonomous administration (Selbstverwaltungsorganization) and discharges the duties of a research financing agency. In this capacity, it may be compared to the Deutsche Forschungsgemeinschaft (DFG) which finances fundamental university research (comparable to our National Scientific Research Center in its role as a "partner"). The AIF plays a comparable role with regard to joint industrial research as well as with respect to the small and medium-sized businesses which receive specific grants in accordance with the federal government program that was decreed in April 1978.

During the last 2 years, the AIF has been oeprating a complete system of encouraging research and development which offers companies three different subsidization programs: the system of joint research, which has been operating since the creation of the agency, the system of issuing contracts to outside organizations and the system of furnishing grants to independent research and development workers which has been in effect during the last 2 years. The joint research projects must be previously examined by the autonomous administrative agency of the AIF. Information regarding the research contracts and their results are considered to be public property and is made available to any potential user. The success of the two new programs is derived partly from the fact that a similar examination is not required and that the results are not transmitted to other companies.

Development of Joint Industrial Research

In 1979, the AIF had at its disposal the sum of DM 73 million provided by the BMWi (Federal Ministry of Economy) for financing joint research assistance, as compared with 67 DM million in 1978. It is expected that the requirements for subsidies will grow considerably during the coming years, especially since the AIF itself has encouraged large industrial division to conduct joint research. Therefore, the AIF would like to have an increase in the financial appropriations from the federal government.

The research funds for external contracting obtained from the BMFT (Federal Ministry for Research and Technology) are relatively small. In 1979, they were increased to DM 8 million (the sum of DM 10 million is planned for 1980) and were distributed among many small projects (527). These subsidies are going to a group of companies which have a total maximum volume of business of DM 200 million. Nevertheless, since three-fourths of the applicants whose requests were approved consisted of companies whose annual volume of business was less than DM 50 million, the amount of the subsidies for 70 percent of the projects was raised to less than DM 25,000, that is, to less than to one-fourth the maximum amount of subsidy authorized (DM 120,000).

Grants to Research and Development Personnel Employed in Small and Medium-Sized Companies

This subsidization program is financed by the BMWi. The Federal Ministry of the Economy has furnished the AIF with approximately DM 390 million in 1980 (compared to DM 300 million in 1979). From the beginning of the program in 1979 until May 1980, DM 318 million were distributed to a total of 4501 applicants. A total of 60,000 individuals was involved, each one devoting at least 400 hours per year to research and development activities. The companies receiving this money were small ones. As much as 64.4 percent of them employ less than 200 people and only 13.2 percent have a work force of more than 500. (In order to qualify for this program, a company must employ less than 1000 workers or have a volume of business of less than DM 150 million).

This program of grants for employment of personnel in research and development work in the small and medium-sized industries is being conducted by one of the Karlsruhe Fraunhofer institutes (the Institut fur System-technik and Innovationsforshung) which is scheduled to furnish a complete report within 2 or 3 years dealing with its impact and consequences.

[Table on following page]

Programme de subvention de l'AIF 1

Situation de l'entreprise 2	Mesure administree par l'AIF 3	Marches à suivre 4
L'entreprise est confrontee à un probleme relatif aux matieres premieres aux procedes ou à la fabrication auquel elle ne peut trouver toute seule une solution 5	Recherche collective industrielle 6	L'entreprise doit appartenir à une association de recherche membre de l'AIF Un certain nombre d'autres entreprises de la même branche doivent être interessees à la solution du même probleme 7
Une entreprise veut résoudre elle-même un probleme technologique de produit procedé ou fabrication, mais elle ne peut le faire sur place Elle doit avoir recours aux services d'un organisme de recherche extérieur 8	Recherche sous contrat externe 9	L'entreprise dépose une demande de subvention directement aupres de l'AIF avant de sous-traiter le projet à un organisme de recherche extérieur 10
Certains travaux de R & D sont effectués dans l'entreprise par ses propres moyens (c'est-à-dire sans aide exterieure ni subvention publique) Elle engage des depenses de personnel de R & D 11	Prime au personnel de R & D 12	L'entreprise dépose pour chaque année en cours une demande de prime pour les coûts de personnel de R & D Le montant de la demande se fait sur la base des dépenses de personnel de R & D engagees l'annee précédente 13

KEY:

1. The AIF subsidization Program.
2. The company's situation.
3. Type of program administered by the AIF.
4. Steps to be taken.
5. The company is faced with a problem concerning raw materials, processes or manufacturing which it appears unable to solve by itself.
6. Joint industrial research.
7. The company must belong to a member research association of the AIF. A certain number of other companies in the same field must be interested in the solution of the same problem.
8. A company wishes to seek a solution by itself to a technological problem concerning the product, process or manufacture, but cannot do this in-house. It must resort to the services of an outside research organization.
9. Research by means of outside contracting.
10. The company shall make application for a subsidy directly to the AIF before subcontracting the project to an outside research organization.
11. Certain research and development work is being performed by the company using its own facilities, that is, without any outside help or public subsidy. It agrees to pay the expenses of research and development personnel.
12. Grants to research and development personnel.
13. The company makes application each year for grants to cover the costs of research and development personnel. The amount of the request is based on the expenses for research and development personnel agreed to the preceding year.

7619
CSO: 3102

FRANCE INCREASES RESEARCH EXPENDITURES

Frankfurt/Main FRANKFURTER ALLGEMEINE/BLICK DURCH DIE WIRTSCHAFT in German 12 Feb p 7

[Text] Frankfurt, 11 February—According to French government figures (DGRST le Progres Scientifique No 208), total French expenditures for research in the past year amounted to F43.5 billion. The increase over 1978 came to 4.6 percent in real terms. The proportion of the GNP is 1.8 percent in France, compared with about 2.1 percent in the FRG and 2.4 percent in the United States. The number of those employed in research is given as 102,000. Of these, 34,500 are in industrial research, 25,500 are in state research institutes and 40,5000 are in research at universities. That means about 35 percent of French research scientists are employed in industry. The situation is similar in the amount spent on research. Forty two percent comes from industry, 58 percent goes to state institutions. This is different than in the FRG or Japan. In both these countries more than 50 percent of research expenditures comes from industry, in Japan it is as much as 59 percent. This can be partially explained by the strong military research and development carried out in the United States, the United Kingdom and France. There is also a remarkable difference in the areas of research financed by French industry. Heading research expenditures by French industry is aerospace, which spent 61.6 percent of the total expenditures for research. Then came the electronics industry and data processing with 22.6 percent. However, the chemical industry, for example, spent only F274 million. Similarly, the other branches of industry have relatively modest budgets. This is in sharp contrast to the FRG, where machine construction and chemicals head the list of research expenditures.

The proportion of the GNP spent on research has scarcely changed in France since 1964, while an increase could be noted in the FRG. The high expenditures for military research and development are remarkable, F9.4 billion in 1979, or 21.6 percent of French expenditures for research, compared with 5 percent in the FRG. Expenditures for nuclear research and nuclear technology show that research expenditures are not the sole standard for the application of new research results. French expenditures for nuclear research in the non-military area are 30 percent lower than comparable German expenditures. In spite of this, France currently has the largest working nuclear energy program among Western industrial countries and is the farthest advanced in developing the closed fuel circuit for nuclear power plants. In large-scale technical projects a close link between state support and application of research results is paying off. This can be seen not only in the case of nuclear energy, but also in air and space travel.

9581
CSO: 3102

DEVELOPMENT, PERFORMANCE OF DAUPHIN 2 HELICOPTER DETAILED

Paris AVIATION INTERNATIONAL MAGAZINE in French 15 Feb 81 pp 24-35

[Article by Jean Perard: "Dauphin 2: 10 Years of Technical Evolution"]

[Text] In 1970, the Helicopters division of Sud-Aviation decided to undertake the designing of the SA-360 Dauphin, intended to take over from the Alouette III's. Since 1972, the year of the initial flight of the first prototype of the Dauphin family, which covers a broad gamut, from oil exploration to antiship warfare, as well as antitank missions, the family has constantly grown, thanks to a great many technological innvoations. This evolution has led to Aerospatiale's being chosen notably by the United States Coast Guard, by China and by Saudi Arabia. In brief, with the "Ecureuil" and "Super Puma" families, the Dauphin family constitutes one of the French company's key assets for the coming decade.

Initially, the definition was for a 10-seat single-engine helicopter with mass varying between 2.5 and 3.5 tons. Four-blade rotor with the blades made of a Nomex light-alloy sandwich. NAT [Not Articulated in Drag] rotor head, and auxiliary rotor of the fenestron type already used on the SA-341 Gazelle.

The Dauphin's engine power was provided by a Turbomeca Astazou XIV of 1,400 HP. Next came the SA-361 Dauphin, an armed military version equipped with a Turbomeca Astazou XV of 1,035 HP. In 1975 the Helicopters division began the designing of a twin-engine machine. At that time, the offshore market emerged, as did commercial transport also. This was the AS-365, equipped with two Turbomeca Arriel A1's of 678 HP (BTP [Main Gear Box]: 750 kW).

In 1976, the technical evolution led to the adoption of a Starflex rotor head driving blades made of a fiberglass-Nomex sandwich. The profile was a NACA 0012.

On the Arriel dual-engine AS-365 C1 and AS-365 C2 versions, the BTP power goes up to 800 kW. The 365 C versions are equipped with a conventional fixed landing gear. In 1978, designing began for the AS-365 equipped with two 735-HP Turbomeca Arriel 1C's, with BTP power of 800 kW. The Dauphin 2 AS-365 N benefitted from the experience acquired with the AS-365 C's upon going into competition in the twin-engine market.

The decision to launch the AS-365 N was taken by the technical management of the Helicopters division in 1977. The first prototype made its initial flight in March 1978. The second prototype flew a few months later. The third specimen constituted the assembly-line model. After a few improvements in the aerodynamic plane, fairing of the BTP and of the engines, increasing the surface area of the fins and fairing of the tail skid, as well as on the blades of the main rotor, a new disposition of the masses of aerodynamic balance and of the blade tips and 3 months after the first flight of the first assembly-line AS-365 N, the machine distinquished itself by smashing, on 6 and 8 February, the Paris-London and return speed records, at average speed of 310 to 320 km per hour--records previously held by the Sikorsky S-76.

At the same time, the 366 G version, planned for the American Coast Guard, was rapidly built. Only the machine's engine power is changed, by the mounting of two 820-HP Lycoming LTS 1010750's. For these search-and-rescue missions, the machine is equipped with sophisticated electronics for which Collins is the prime contractor. The rescue equipment includes sliding doors, recovery baskets, three stretchers, and four assistants, including two paramedics.

It is thus the AS-366 G that was chosen by the Coast Guard committee. The criteria considered in its favor are the following: structure made 55-percent of composite materials, eliminating all risk of corrosion; large usable space (5 m^3); speed, range and maintenance characteristics improved.

The AS-365 N Dauphin 2

Visually, the AS-365 C and the AS-365 N look like brothers. Actually, though, 90 percent of their constituent elements are different, consisting in optimization of the new machine on the basis of the AS-365 C.

Among the new elements we mention: the main rotor, the fuselage structures as a whole.

All the systems have been redesigned with a view to simplification, so as to gain working time. Those systems affected by the modifications are the arrangement of the flight controls and the mounting of the servocontrols on the BTP.

The structure of the AS-365 N is composed 20-percent of composite materials, stratified fiberglass-Nomex, fiberglass-Kevlar and fiberglass-Ronacell. Carbon fiber is used for "Starflex" elements and for the blades. Carbon fibers are also found in the stabilizer. Obviously, these elements do not have a "working" function. Thirty-five percent of the fuselage structure consists of elements made of Nomex light-alloy sandwich, such as the central body of the fuselage, the vertical screens of the fuel-tank compartment, the cabin floor and the fuel-tank base. The rear girder is likewise made of these elements, as is also the mechanical floor of the BTP. Twenty-five percent of the structure is of conventional construction. It is in fact the skeleton of this structure that takes the stresses. This basic structure is composed of the forward cabin doors, the milled main frames at the level of the BTP, the rear main frame of the central body, the secondary frame on the hold floor, and the rear frame of the central body. These main frames are connected to one another by longerons and stiffeners. This skeleton is reinforced at various points: the forward part, the nosewheel and screw-jack attachment points. In the central body is the BTP mechanical floor, the main landing-gear fittings and screw-jack attachments, and the mechanical floor with engine mounts.

The skeleton is covered by AU4G-Nomex sandwich elements for the whole of the fuselage. These "nonworking" elements are easily removable and permit easy maintenance. The use of these composite materials reduces work time and maintenance time by 25 percent. This 25-percent difference by comparison with the 365 C is due to the heavier and more complicated structure of the latter. The composite-materials structure makes it possible to gain on weight and especially on volume, because of the lesser thicknesses of the subassemblies. Because of this, the AS-365 C-type structures have disappeared on the 365 N's.

The main rotor has a "Starflex" hub analogous to that of the 365 C type. This hub has been reinforced as regards the central part of the four-branch star. The bushes, the lugs, and the frequency adapters, to cope with the increase in the increase in the total mass of the machine [as published]. These reinforcements have been made by the introduction of carbon fibers for certain elements, particularly the blade-arm bushes. Fiberglass, though, is the material used in making the hub, offering advantages from the point of view of fatigue resistance, fail-safe character, insensitivity to corrosion, as well as reduced maintenance. The rotor can be stripped down in winds of 70 km per hour, with the addition of high flapping stops. Rotor elements have been stripped down in winds of up to 128 km per hour.

The blades, which are new, are the first ones to have the benefit of the new series of OA 2 profiles developed in cooperation with ONERA [National Office for Aerospace Studies and Research]. The specifications for this study made it possible to define the coefficient of maximum lift, the Mach numbers of drag divergence and the coefficients of moments. From these studies there resulted a revolutional profile OA 212 (12 percent) at the socket, OA 209 (9 percent) at the middle of the blade, OA 207 (7 percent) at the tips, with a twist of 10°. The last modification made on this blade, for the assembly-line version, consisted in putting on the end of it a tip with a deflection of 45°, thus raising the rotor diameter from 11.68 m to 11.93 m and producing a reduction of the alternating stresses in the controls, an increase in speed for the same power, and a slight improvement in the vibration level. Extension of the trailing-edge tab to the blade extremit gives a chord increase from 385 to 405 mm

The construction of these blades differs from that of the model 365 C (see detail drawing).

The fuselage is changed entirely from that of the model 365 C. The internal volume of the cabin is roughly the same. The flight-controls pedestal has been eliminated, with the steering going from the pilot station to the mechanical floor now passing laterally in the side struts of the main frames.

The hold, located aft, communicates by a large opening between the cabin and the central body of the fuselage. The forward part of the cabin structure has been elongated for the pilot stations. On the other hand, the spar frame linking the central body and the rear girder has been reduced. The lower part of the structure has been redesigned to enlarge the fuel-tank compartments and to receive the main landing gear at the level of the central body.

The port and starboard bays on either side of the tanks are used for the circuits and their equipment, the flight controls, the cabin heating, the electric wiring, the fore and aft emergency flotation system and the automatic footboards. The main landing-gear compartments are enlarged to permit installation of a very flexible landing gear in them.

Thee structure forward of the pilot station is composed of a radome which improves the esthetics and provides space for housing electrical equipment and a radar in it.

Access to the cabin is by four doors--two for the crew and two for the passengers. Large-size sliding doors can be mounted optionally for missions using a winch.

The aerodynamics of the fuselage have been modified, starting from the rear frame of the central body, by increasing the surface area of the connecting frame, permitting revolutional construction of the central body-rear girder group all the way to the tail. One thus avoids the disengagements between the central-body elements and the rear girder that the model 365 C had, thus producing an aerodynamic advantage. The fairing of the BTP and of the engines has been done with particular care, and the addition of a rotor-hub fairing has reduced the drag from hub-fuselage interaction, and ultimately, the machine's total drag. The coefficient of surface drag, which was 1.40 m^2 on the AS-365 C, has been reduced to 1.05 m^2. It is this sizable reduction of drag, added to the aerodynamic qualities of the rotor blades, that made possible the Paris-London and return speed record.

As regards the after part, the positioning of the empennages was defined in the course of the in-flight adjustments. It gives the machine excellent flying qualities without automatic stabilization. The two lateral fins have a setting of 10°. Viewed in plan, this aerodynamic setting toward the left in relation to the plane of symmetry completely eliminates the thrust from the antitorque rotor, resulting in a saving of power and elimination of fatiguing of the fenestron, the blades, the BTA [Rear Gearbox] and the pitch control.

The drives are very close, in their definition, to those of the 365 C. Nevertheless, the BTP has been reinforced so as to be capable of transmitting total power of 1,168 HP (860 kW). In case of failure of an engine, the power remaining available can be raised to 880 HP (600 kW) on a single drive shaft.

As regards the BTP reducer, the teeth of the gearing and adjustment of them at the correction stage have been revised for better engagement, reducing the noise level. Freewheels have been incorporated into the lateral drive shafts of the BTP in order to eliminate the maintenance problems associated with lubrication of the external freewheels of the model 365 C.

The lubricating oil of the BTP and the engines is cooled by a fan mechanically driven by a shaft connected to the primary reducer by a conical countershaft. This shaft also receives the rotor-brake disc. The fan sucks air through the radiators from the air intake of the upper cowling. The radiator's air intake is positioned in a pressure zone, in translational flight. Cooling is thus ensured even in case of breakdown of the fan. The oil loop circuit goes from the reservoir to the pump of each engine and then returns, after lubrication, to the radiator before going back into the reservoir. In addition to the rotor power takeoff, the BTP also drives the lateral drive shafts, the hydraulic pumps of the servocontrol circuits, the cyclic-pitch plate on the BTP.

The antivibration suspension comprises a device for suspension of the BTP and the rotor hub that enbales the total unit to pivot around the point of convergence of the BTP connecting rods. But the system that transmits the torque to the structure, while ensuring the necessary flexibility of transfer, from the BTP base, is a new one. For longitudinal flexibility, it uses the flexibility of the fiberglass connecting rods. This apparatus is lighter than that of the AS-365 C.

The main rotor controls have been modified, in relation to the 365 C, for the control pedestal going from the pilot station to the floor (see "Structure of Fuselage" section). The control pedestal on the mechanical floor drives the three double-body servocontrols directly. On the port side is a connecting-rod countershaft for the port roll servocontrol and a connecting-rod countershaft and shafts for the pitch servocontrol. On the starboard side, the control pedestal has a relay and the drive-rod of the starboard-roll servocontrol. This solution is a simple one and involves few parts, hence ease of maintenance.

As regards the 365 C, half of the control pedestal for the servocontrols was under the mechanical floor and the other half was on it. The control-pedestal unit has an automatic pilot of the Duplex SFIM [Measuring Instruments Manufacturing Co] 85 type, equipment necessary for IFR [Instrument Flight Rules].

On the control pedestal for cyclic pitch and collective pitch are mounted, at the point between the two levers, two electrical screw-jacks assisted by two trim cases --also electric--for roll and pitch. The lever bases are equipped with cyclic balancing. Only the fenestron control is not reduplicated. Furthermore, the stresses for control of the pitch servos in translational flight are very weak. A double servocontrol is therefore not a necessity. These stresses increase only for stationary flight before landing, and the double servocontrols are then used for that purpose.

Some Figures

Characteristics--Diameter of main rotor: 13.29 m. Diameter of fenestron: 0.90 m. Length of fuselage: 11.41 m. Height (fin): 4 m. Undercarriage track: 1.90 m. Wheelbase: 3.61 m. Cabin dimensions: length, 2.30 m; width, 2.03 m; height, 1.40 m. Floor surface area: 4.20 m^2. Cabin volume: 5 m^3. Mass empty, equipped: 1,850 kg. Maximum mass: 3,400 to 3,800 kg.

Performance Characteristics at Mass of 3,800 kg--Maximum speed: 306 km/hr. Fast cruising speed: 292 km/hr. Economic cruising speed: 250 km/hr. Oblique-flight climbing speed: 7 m/sec. Range at economic cruising speed, with standard fuel tanks: 915 km. Range with extra fuel tank: 1,040 km. Maximum time range at 130 km per hour: 4 hr 30 min. Fuel consumption at economic speed: 1 kg/km. Oblique-flight ceiling: 4,850 m. Stationary ceiling with ground effect: 2,350 m (ISA [International Standard Atmosphere]). Stationary ceiling, ISA + 20° C: 1,400 m. Stationary ceiling without ground effect: 1,200 m.

Performance Characteristics at Mass of 3,400 kg--Maximum speed: 315 km/hr. Fast cruising speed: 297 km/hr. Economic cruising speed: 255 km/hr. Oblique-flight climbing speed: 9 m/sec. Range at economic cruising speed: 957 km. Range with extra fuel tanks: 1,117 km. Time range at 130 km/hr: 4 hr 35 min. Fuel consumption at economic cruising speed: 0.98 kg/km.

Improvement of Performance Characteristics

The essential performance characteristics of the AS-365 N helicopter represent a very distinct advantage over the anticipated official specifications.

The qualities of the main rotor have made it possible to increase the total weight from 3,600 to 3,800 kg, while the mass-empty remains at 1,900 kg, almost that of the model AS-365 C. Despite the mounting of a retractable tricycle landing gear, quite a bit heavier than the conventional gear, a rotor of higher performance has been obtained with a strengthened BTP. In addition, there are the supplementary doors for the pilot stations, the larger-capacity fuel tanks, and various structural reinforcements.

The maximum takeoff weight is considerably greater than anticipated, especially that in category A (FAA), which goes from 3,250 kg in ISA conditions at altitude 0 (+15° C) to 3,800 kg in ISA + 20° C. Because of this, the payloads are considerably higher.

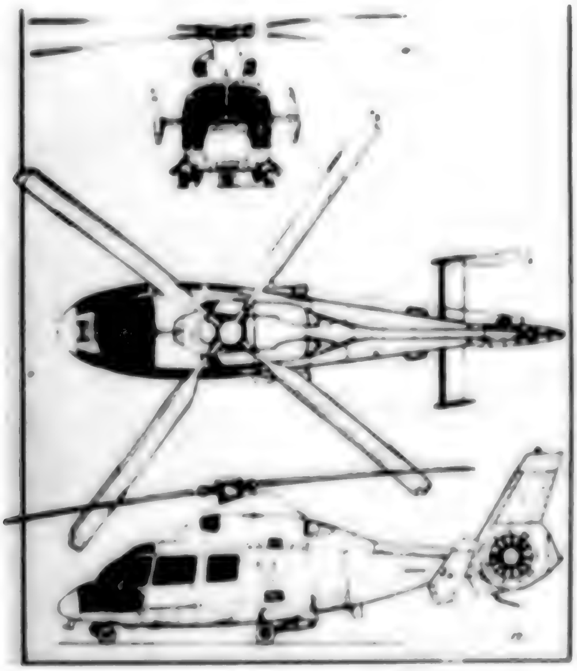
The original specifications provided for an empty weight of 1,900 kg and a gross weight of 3,600 kg. As for the performance characteristics anticipated, the stationary-flight ceiling without ground effect, ISA, was supposed to be 1,050 m, and in ISA + 20° C, 0 m.

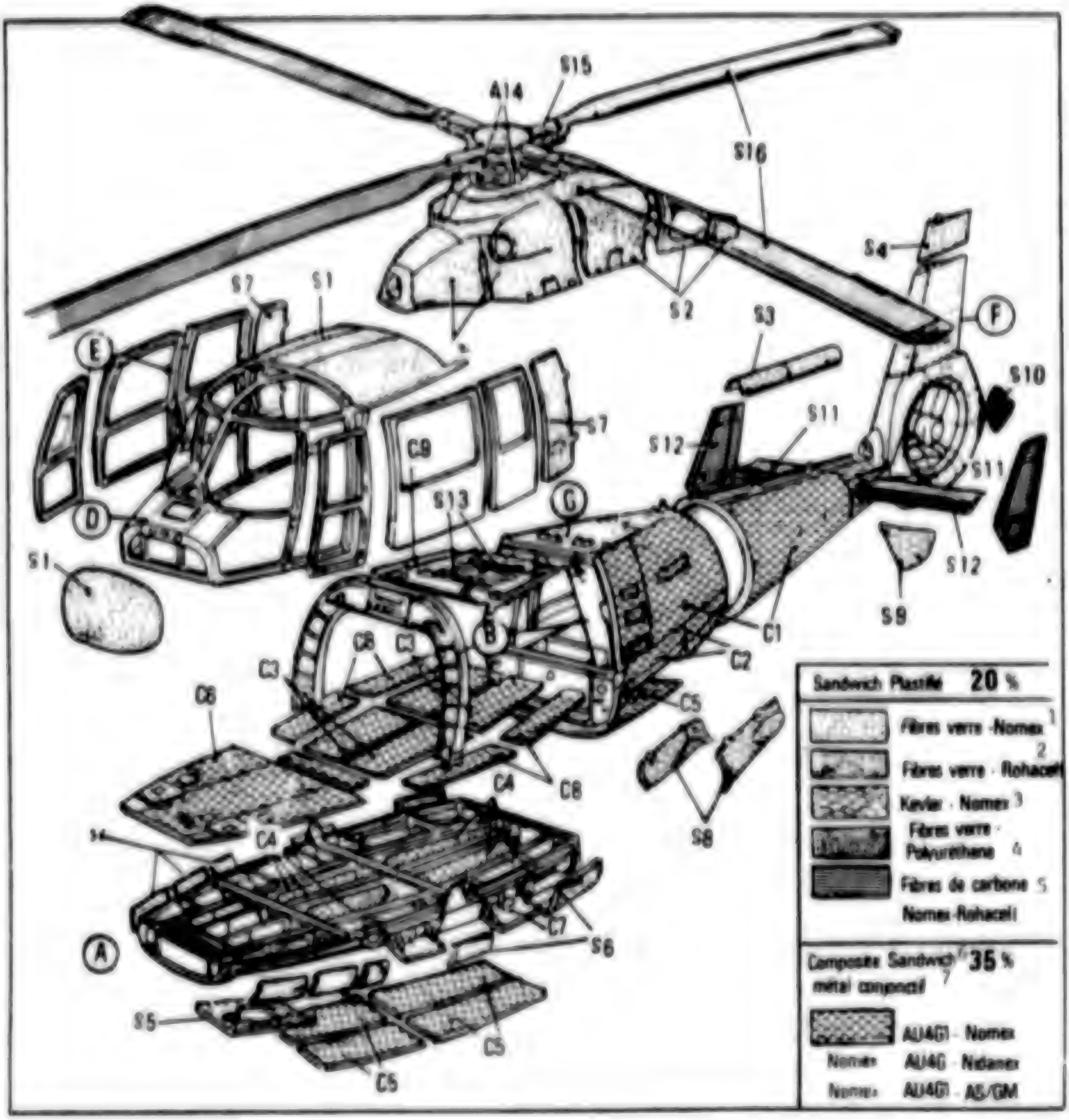
Actually, the fast cruising speed reaches 278 km/hr, the economic cruising speed being 247 km/hr. At 247 km/hr, fuel consumption proves to be 1.08 kg/km. The range is 850 kgm [as published]. For 800 km, the payload at takeoff (FAA) is 712 kg.

Results Obtained--The empty weight is therefore 1,900 kg, and the gross weight is 3,800 kg. The stationary ceiling without ground effect in ISA conditions is 1,900 m, and the stationary ceiling without ground effect in ISA + 20° C conditions is 1,000 m. The fast cruising speed is 297 km/hr, and economic cruising speed is 240 to 250 km/hr. In this case, fuel consumption is 1 kg/km. The range is 900 km. For a distance of 800 km, the payload is 924 kg. The sling load is 1,500 kg.

[p 24, photo and drawing]

Above , an in-flight view from the rear showing the revolutional line of the fuselage, with its contoured cowlings, as well as the retractable landing gear, all of it giving the machine as a whole a very low coefficient of drag. Below, a three-view drawing of the AS-365 N version of the Dauphin 2. In the plane view can be noted the 10° setting of the fins.





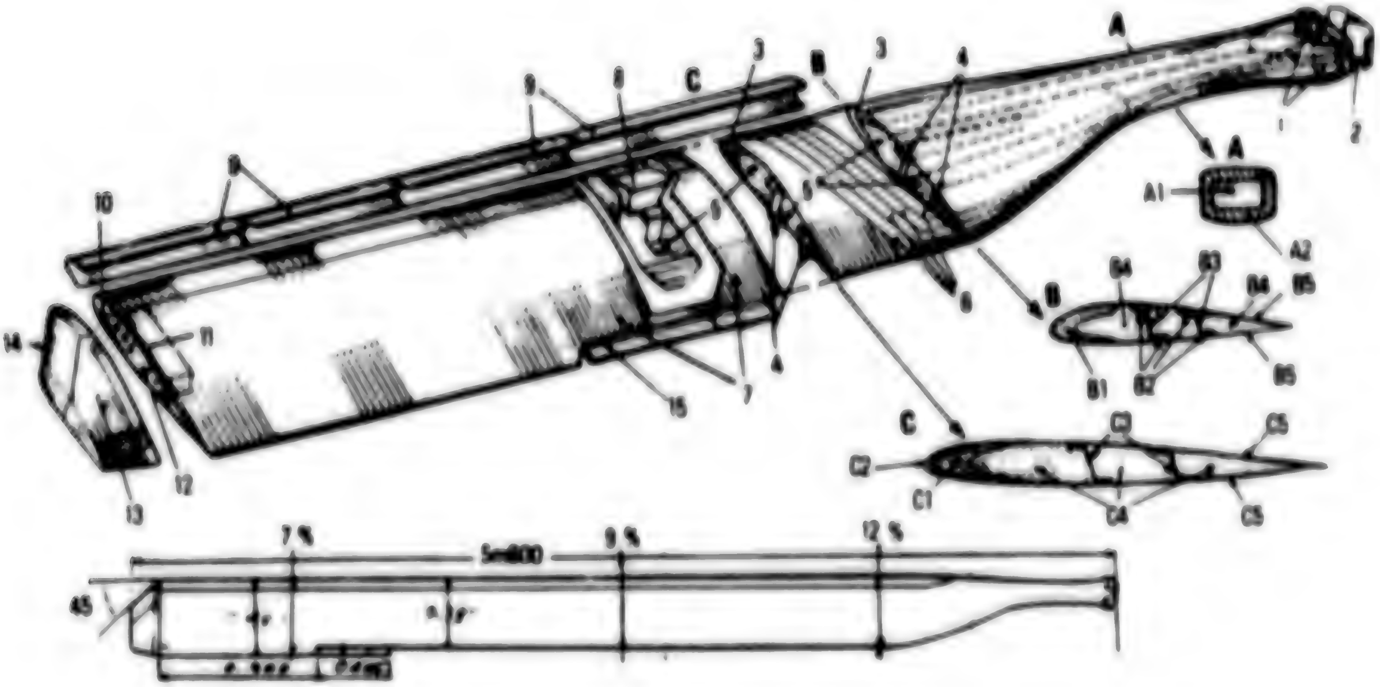
[p 26, drawing]

[Key]: 1. Fiberglass-Nomex. 2. Fiberglass-Ronacell. 3. Kevlar-Nomex. 4. Fiberglass-polyurethane. 5. Nomex-Ronacell carbon fibers. 6. Sandwich composite. 7. Connective metal.

[Legend]: Materials of the Structural Elements of the AS-365 N - 1. Stratified-sandwich elements - 20 percent of structure. Nomex glass cloth: S1. Radome and upper cover of cabin. S2. Cowlings of BTP and turbines. S3. Cowlings of drive shaft. S4. Fin tips. S5. Lower cover of nosewheel housing. Ronacell glass cloths: S6. Covers of inspection ports on fuselage fairing. S7. Rear cabin doors. Kevlar-Nomex: S8. Main-landing-gear hatches. S9. Tail-skid fairing. Fiberglass-Polyurethane: S10. Rear tip of fenestron. Carbon-fiber cloths, Nomex-Ronacell sandwich: S11. Stabilizer. S12. Lateral fins. Fiberglass-resin: S13. Connecting bars. Flexible antivibration suspension for BTP-mechanical floor structure. S14. Blade-pitch control rods. Composite of fiberglass-resin and laminated stops: S15. "Starflex" rotor head. S16. Blades of spun-fiber composite. Carbon fibers, blade reinforcement, longeron and polyurethane foam [as published]. Composite elements, AU4G metal-Nomex sandwich, 35 percent of structure. C1. Central element of fuselage and rear girder. C2. Landing-gear compartment panels and rear flotation compartments. C3. Cover of main fuel tanks. C4. Fuel-tank firewalls. C5. Cover under central part of fuel tanks. C6. Pilot-station floor. C7. Automatic footboard. AU4G-Nomex sandwich: C8. Inspection ports, flight controls. AU4G-AS/GM sandwich: C9. Mechanical floor, BTP. Metal Structural Elements of AU4G: A. Forward fairing. B. Main frames. C. Rear floor, engine support. D. Forward cabin structure, windshield, door frames. E. Cabin doors. F. Fenestron structure. G. Fin.

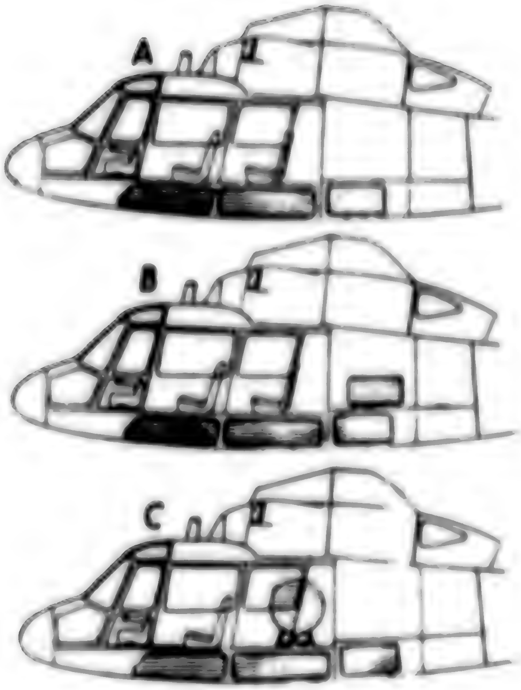
[p 27, photo at bottom right]

The hull structure of the fuselage is made of AU4G1 light alloy. The lower frames receives, in the center, the four main tanks, and in the rear, a fifth tank, with transfer system. The flight controls, the different circuits, the footboards and the landing gear are housed in the lateral bays. Three milled main frames receive the covering of sandwich-composite material.



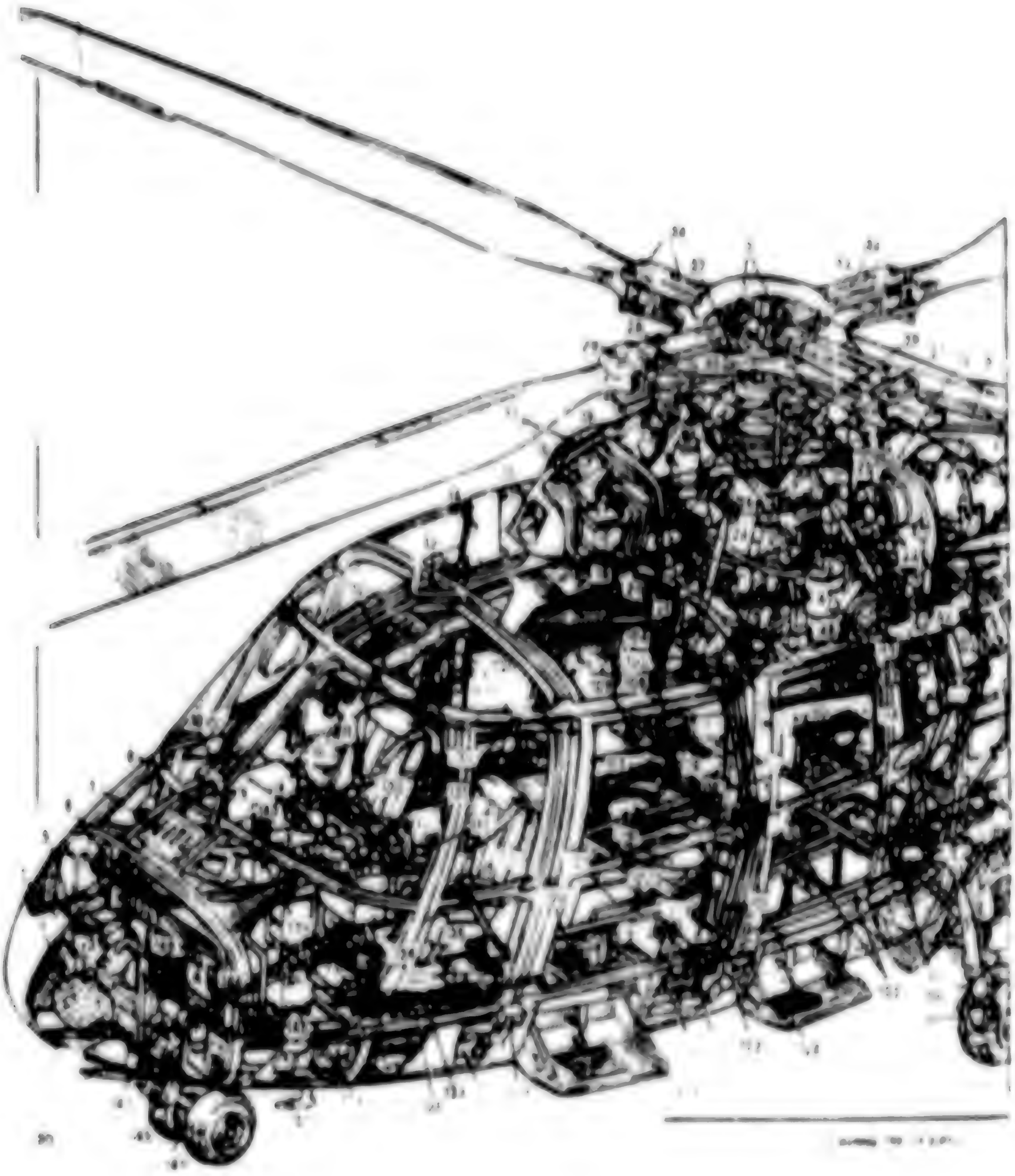
[p 27, drawing at top]

The New Blades--AS-365 N blades. OA 2 profile - Relative thickness revolutional from 12 percent to 9 percent and 7 percent, with twist of -10° at end. 1. Axle sleeves. 2. Stop. 3. Spun fiberglass of leading edge. 4. Carbon-fiber longeron. 5. Blade filling of expanded polyurethane foam. 6. Carbon-fiber blade-shank reinforcement, six regressive layers crossed at 45°. 7. Top and bottom faces of carbon fibers crossed 45°. 8. Balancing mass of brass (6.5 kg). 9. Leading-edge protection of stainless steel. 10. Lead counterweight. 11. Balancing chamber. 12. Mass support. 13. Blade tip of carbon fiber (45° angle). 14. Leading edge of tip 15. Tabs adjustable on ground. Section A - blade shank - A1. fiberglass-resin. A2. Expanded-foam filling. Section B - B1. Leading edge of spun fiberglass-resin. B2. Internal longeron reinforcements of fiberglass. B3. Carbon-fiber longeron. B4. Expanded polyurethane foam filling. B5. Cover of carbon fibers crossed at 45°. Section C - C1. Leading edge of fiberglass-resin. C2. Leading-edge protection of stainless steel. C3. Carbon-fiber longeron. C4. Expanded-foam filling. C5. Carbon-fiber covering.



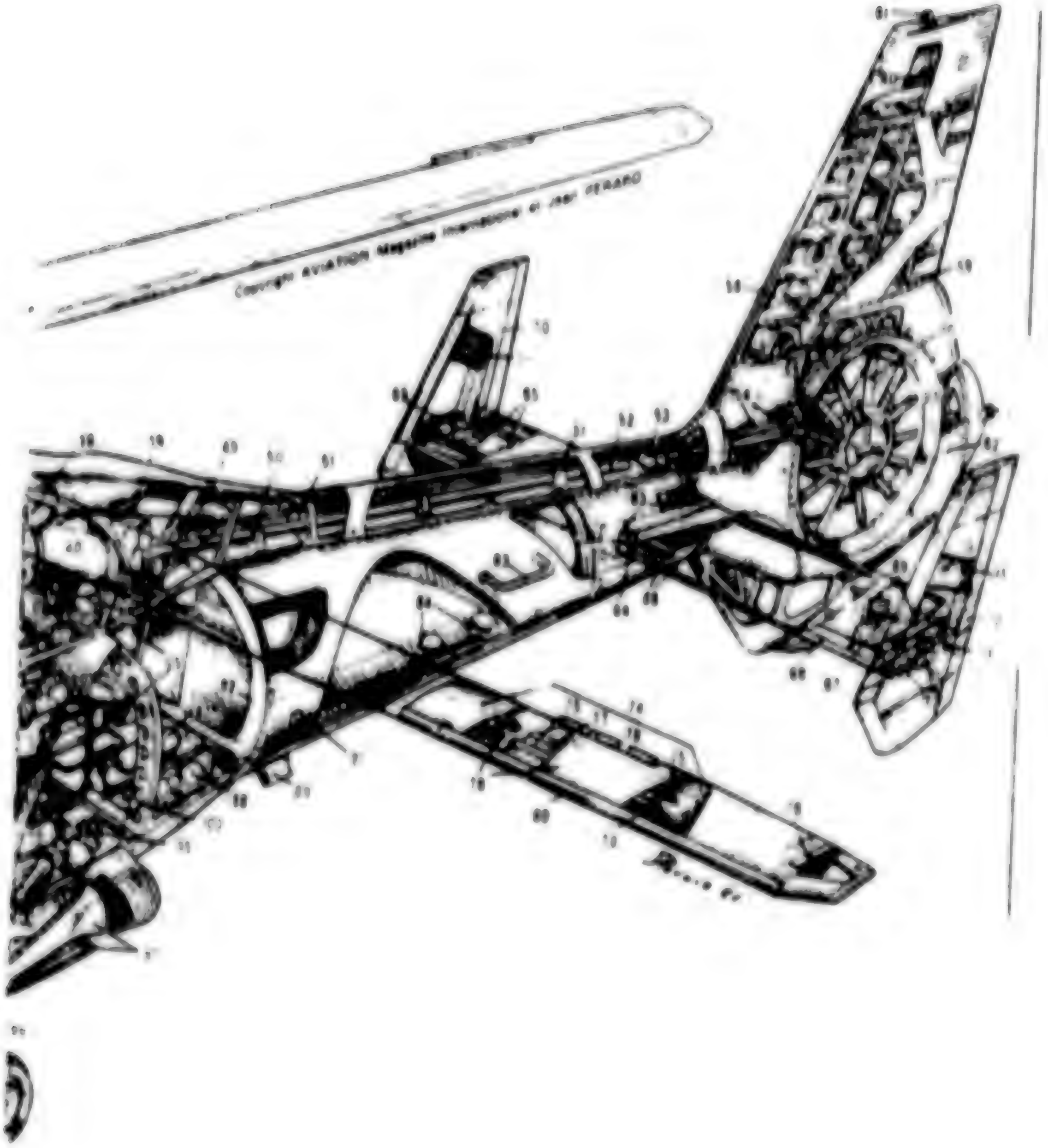
[p 27, drawing at bottom]

Arrangement of Fuel Tanks - A. Standard tank (1,140 lit). B. Extra tank in cargo hold (1,140 + 180 = 1,320 lit). C. Ferrying tank in cabin (1,140 + 475 = 1,615 lit).



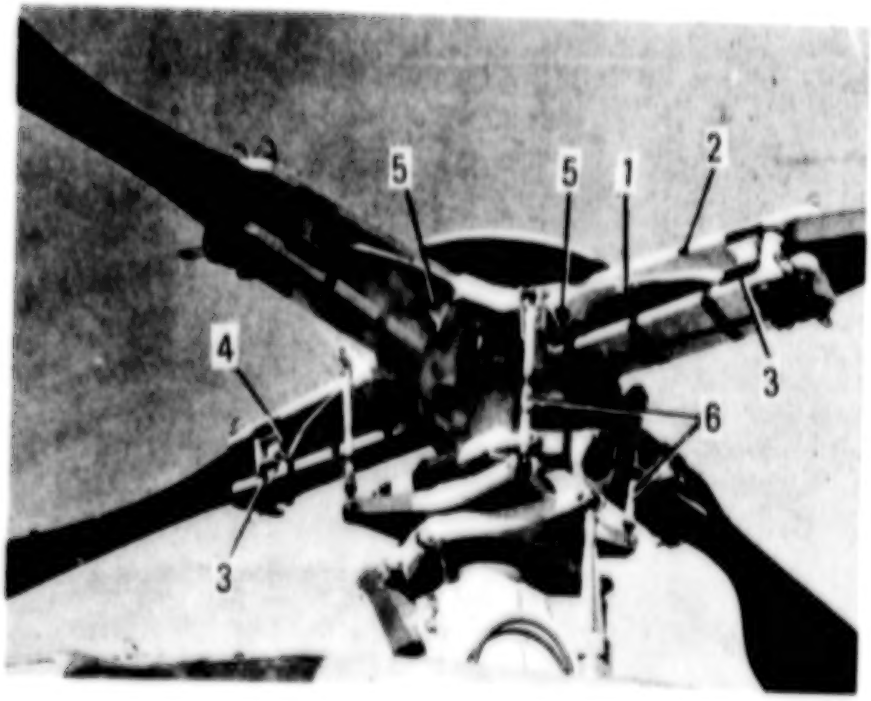
[pp 30-31]

1. Sperry 1406 multifunction radar. 2. Radome. 3. Electrical equipment. 4. Battery. 5. Rudder-bar for control of rear rotor (yaw). 6. Rudder-bar pedals with braking-distribution and direction-control cylinders (for rolling on ground). 7. Air intake for cabin ventilation, hot air-cold air mixer, cabin air-conditioning. 8. Hot-air nozzle, windshield defogging. 9. Cabin cold-air circuit. 10. Deicer. 11. Engine controls, fuel shutoff cock, flow, rotor brake. 12. Engine-controls pedestal. 13. Fresh-air distribution circuit with control. 14. VHF 1 antenna. 15. Oil-radiator air intake. 16. Tank, hydraulic circuit, landing gear, brake and rotor servocontrols. 17. Cooled dynamic air intake. 18. Oil radiator, engine-lubrication circuit. 19. Engine-oil circuit, radiator and tank. 20. Rotor brake.



21. Hydraulic pumps, rotor servocontrols. 22. Radiator fan. 23. Starboard-roll double-body servocontrol. 24. Port-roll servocontrol. 25. Servocontrol for pitch. 26. Main gearbox (BTP). 27. Cyclic plate, servocontrols. 28. Turning plate. 29. Turning-plate arm. 30. Rotor post. 31. Attachments of blade arms to "Starflex" star. 32. Flapping support. 33. "Starflex" star. 34. Blade arms and attachments. 35. Forward firewall. 36. Turbomeca "Arriel" 1C 608-HP turboengine. 37. Central firewall. 38. Rear firewall. 39. Exhaust nozzle. 40. Turboengine reducer. 41. Drive shaft. 42. Fuel filter, engine fuel supply. 43. Rear mechanical-floor engine mounts. 44. King-rod and mountings, BTP mount. 45. Mechanical floor of BTP. 46. Engine-oil reservoir. 47. Engine-oil circuit. 48. Hydraulic circuit for servocontrols. 49. Control countershaft to BTA (rear). 50. Sliding rod for

control of rear rotor. 51. Teflon guide-bearing for sliding rod. 52. BTA drive-shaft bearing. 53. Control countershaft, pitch rod, rear rotor. 54. Rear-rotor hydraulic-servocontrol connecting rod. 55. BTA. 56. Rear rotor hub. 57. 13-blade rear rotor. 58. Main fin. 59. Edge ribbing. 60. Fin tip of laminated material. 61. Navigation lights. 62. Fairing of fenestron. 63. Main frames, stabilizer attachments. 64. Attachment of stabilizer to fuselage girder. 65. Carbon-fiber stabilizer longerons. 66. Stall fence. 67. Top-and-bottom surface covering of transverse 3-ply carbon fibers crossed at 45°. 68. Stabilizer mounting. 69. Ribbing of stratified carbon and expanded polyurethane foam. 70. Lateral fin of stratified material, fiberglass. 71. Nida-Nomex filling. 72. Leading and trailing edges of expanded foam. 73. Fore and aft fin attachments to edge ribbing. 74. Blades of composite materials. 75. Longeron. 76. Carbon-fiber blade covering. 77. Expanded polyurethane-foam filling. 78. Balancing mass. 79. Compensation tabs. 80. Leading edge of stainless steel. 81. Fuselage girder of sandwich composite of light metal-Nida Nomex. 82. Rear fuselage-girder connecting frame. 83. VOR-LOC antenna. 84. Radioaltimeter antenna. 85. BTA control pedestal. 86. Engine-extinguisher cylinders. 87. Helium cylinders for flotation system. 88. Rear flotation balloon. 89. VHF 2 antenna. 90. Expansion reservoir and reservoir-pressurizing circuit. 91. Fuel circuit to engine. 92. Hot-air tapping circuit, cabin air-conditioning. 93. Converter to electrical circuit. 94. Voltage regulator. 95. Mountings for attachment of screw-jack for raising landing gear, landing-gear compartment. 96. Landing-gear hydraulic screw-jack. 97. Landing-gear ports of stratified Kevlar-Nomex sandwich. 98. Landing-gear mounts. 99. Landing-gear strut. 100. Landing-gear oleopneumatic shock absorber. 101. Wheel equipped with hydraulid disc brakes. 102. Fuselage fairing structure of light alloy. 103. Milled main frame. 104. King-rod and mountings of BTP mount. 105. Roll-servocontrols countershaft to control pedestal. 106. Pitch-servocontrol countershaft to control pedestal. 107. Roll-pitch control rods. 108. Roll-pitch control-rod relay. 109. Rear-rotor control pedestal. 110. Attachment of screw-jack to structure. 111. Control relay, rear rotor. 112. Rear fuel tank. 113. Transfer pump, rear tank, central tank. 114. Fuel-tank filler hole. 115. Central body of AU4G-Nomex composite. 116. Fuel circuit to engine. 117. Starboard-side central fuel tank. 118. Port-side central fuel tank. 119. Gravity tank for fuel circuit. 120. Fuel booster pump. 121. Fuel circuit, booster pump and vacuum pump. 122. Vacuum pump, fuel circuit. 123. Hot-air circuit, cabin. 124. Automatic footboard forward of doors. 125. Collective-pitch and cyclic-pitch combiner. 126. Cyclic-pitch connecting rod. 127. Collective-pitch connecting rod. 128. Roll-pitch servocontrol relay, collective pitch. 129. Collective-pitch lever, pilot. 130. Collective-pitch lever, copilot. 131. Collective-pitch control pedestal. 132. Pitch trim, automatic pilot. 133. Automatic-pilot electrical screw-jack, roll. 134. Relay for controls. 135. Electrical screw-jack for pitch. 136. Cyclic-pitch lever base and control pedestal, roll and pitch. 137. Control-pedestal relay, cyclic pitch. 138. Cyclic balancing. 139. Control pedestal for conjoining pilot and copilot levers. 140. Pilot and copilot levers. 141. Central Nav-Com radio console. 142. Instrument panel. 143. Nav-Com radio equipment. 144. Hydraulic screw-jack for nosewheel. 145. Roll trim, automatic pilot. 146. Nosewheel mounting to structure. 147. Nosewheel. 148. Steerable bogie of nosewheel. 149. Oleopneumatic shock absorber of nosewheel. 150. Antenna for letting down by ILS [Instrument Landing System]. 151. Pitot antenna, airspeed indicator circuit.



[p 34, upper photo]

The Starflex rotor head is made of fiberglass and carbon composite. 1. Starflex star. 2. Blade-attachment arms. 3. Frequency adapters. 4. Swivel-joints for attaching star to frequency adapters. 5. Spherical flapping bearings, elastomer. 6. Fiberglass pitch-control connecting rods.

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TRANSPORTATION

MINISTRY REPORTS GOOD POTENTIAL FOR ELECTRIC VEHICLES

Frankfurt/Main FRANKFURTER ALLGEMEINE in German 5 Mar 81 p 7

[Text] Bonn, 4 March—The government and the opposition in Bonn are agreed that the electric car shows promise, at least in short distance transportation: A report, which the Ministry of Transport is sending to the Bundestag, says that the use of electrically powered vehicles is technically possible, as test experience has shown; CDU delegate Gerhard O. Pfeffermann said on Wednesday that the report confirmed the Union's concept of the possible--even if limited--application for cars that derived their power from a wall-plug.

The ministry sees possibilities for the electric car primarily in local freight delivery. In the utility vehicle area (including buses), the report says that, at a careful estimate, 80,000 to 90,000 such vehicles could be on the road. Recommendations about practical use are expected from the Bundespost's experiment, in which electric light pick-ups were used for package delivery.

In the private sphere, the ministry sees the possibility of replacing with electric cars up to 40 percent of the approximately 2.5 million second cars, which are driven mainly in city traffic. Improvements in the batteries are considered essential. It is primarily a question of reducing the high weight and increasing the output.

The government plans to continue support for development of the so-called traction batteries. So far Bonn has given DM 100 million to support the electric car, while the industry involved has spent DM 185 million. The ministry cautions that, at least with limited production, electrical vehicles will not be economical at first because of the high investment costs. On the other hand, the ministry sees no problem in supplying current for electric vehicles; the report says that a sufficient number of power plants is available; the night time availability of current must also be mentioned.

At the moment the ministry is reacting extremely cautiously to the question whether a greater future could lie ahead of the electric vehicle in the FRG; the report notes that considerable measures would be necessary in the case of the electric car, while the conversion of vehicles being manufactured today to methanol fuel, for example, is associated with a relatively low cost.

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